CHAPTER 1

THE BACK

The back region contains the **superficial muscles of the back (posterior thoracoappendicular muscles)**, the **intermediate muscles of the back,** and the **deep muscles of the back**. All of these muscles attach to the vertebral column. The vertebral column serves the dual purpose of forming the axis of the body and providing a protective bony covering for the spinal cord.

SURFACE ANATOMY

The surface anatomy of this region may be studied on a living subject or on the cadaver. In the cadaver, fixation may make it difficult to distinguish bone from well-preserved soft tissues. Turn the cadaver to the prone position (face down) and palpate the following structures (Fig. 1.01): **[N 145]**

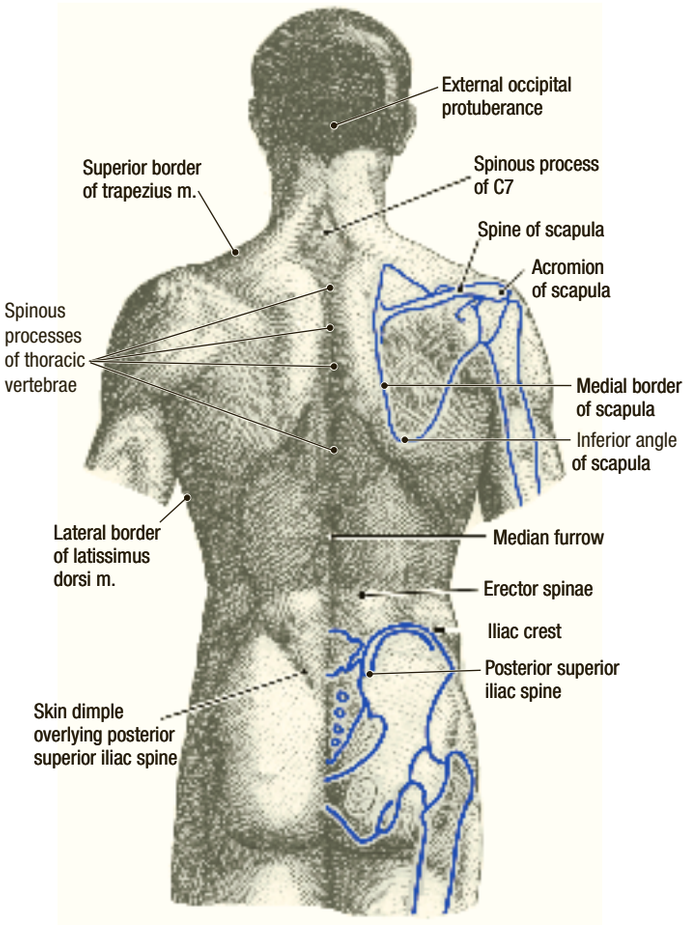


Figure 1.01. Surface anatomy of the back.

KEY TO REFERENCES
G = Grant's Atlas, 11th ed., page number
N = Netter's Atlas, 3rd ed., plate number
R = Rohen's Color Atlas of Anatomy, 5th ed., page number
C = Clemente's Atlas, 4th ed., page number

- **External occipital protuberance**
- **Superior border of the trapezius muscle**
- **Spinous process of the 7th cervical vertebra (vertebra prominens)**
- **Spine of the scapula** (at vertebral level T3)
- **Acromion of the scapula**
- **Medial (vertebral) border of the scapula**
- **Inferior angle of the scapula** (at vertebral level T7)
- **Spinous processes of thoracic vertebrae**
- **Erector spinae muscle** (most noticeable in the lumbar region)
- **Median furrow**
- **Lateral border of the latissimus dorsi muscle (posterior axillary fold)**
- **Iliac crest** (at vertebral level L4)
- **Posterior superior iliac spine**

SKELETON OF THE BACK

Refer to a skeleton. On the **scapula**, identify (Fig. 1.02): **[G 459; N 404; R 359; C 70]**

- **Acromion**
- **Spine**
- **Superior angle**
- **Medial (vertebral) border**
- **Inferior angle**

On the **ilium**, identify (Fig. 1.02): **[G 299; N 152; R 184; C 249]**

- **Iliac crest**
- **Posterior superior iliac spine**

On the **occipital bone**, identify (Fig. 1.02):

- **External occipital protuberance (inion)**
- **Superior nuchal line**

On the **temporal bone**, identify (Fig. 1.02):

- **Mastoid process**

The **vertebral column** (Fig. 1.02) consists of 33 vertebrae: 7 cervical (C), 12 thoracic (T), 5 lumbar (L), 5 sacral (S), and 4 coccygeal (Co). The upper 24 vertebrae (cervical, thoracic, and lumbar) allow flexibility and movement of the vertebral column, whereas the sacral vertebrae are fused to provide rigid support of the pelvic girdle. A typical thoracic vertebra will be described, and the cervical and lumbar vertebrae will be compared to it. **[G 276; N 146; R 189; C 422]**

Refer to a disarticulated **thoracic vertebra** and identify (Fig. 1.03): **[G 286; N 147; R 186; C 423]**

- **Body**
- **Vertebral arch –** formed by the combination of pedicles and laminae
- **Pedicle** (2)
- **Lamina** (2)
- **Vertebral foramen**

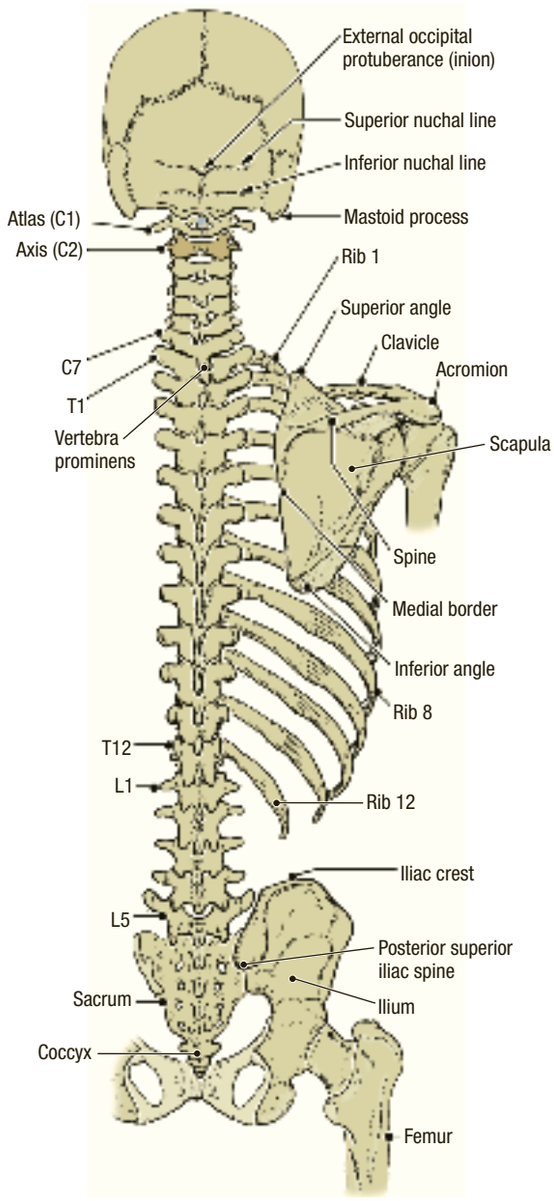


Figure 1.02. Skeleton of the back and vertebral column.

- **Transverse process** (2)
- **Transverse costal facet**
- **Spinous process**
- **Articular processes –** superior and inferior
- **Vertebral notches –** superior and inferior
- **Costal facets –** superior and inferior

The spinous process of a thoracic vertebra is long, slender, and directed inferiorly over the spinous process of the vertebra that is inferior to it. Articulation with ribs is a unique characteristic of thoracic vertebrae. The head of a rib articulates with the bodies of two adjacent vertebrae (Fig. 1.04). The tubercle of a rib articulates with the transverse costal facet of the thoracic vertebra of the same number (i.e., the tubercle of rib 5 articulates with the transverse costal facet of vertebra T5). An **intervertebral disk** and the **articular processes** unite two adjacent vertebrae. The vertebral notches of two adjacent vertebrae combine to form an **intervertebral foramen**. A spinal nerve passes through the intervertebral foramen.

Cervical vertebrae differ from thoracic vertebrae in the following ways (Fig. 1.05): cervical vertebrae have smaller bodies,

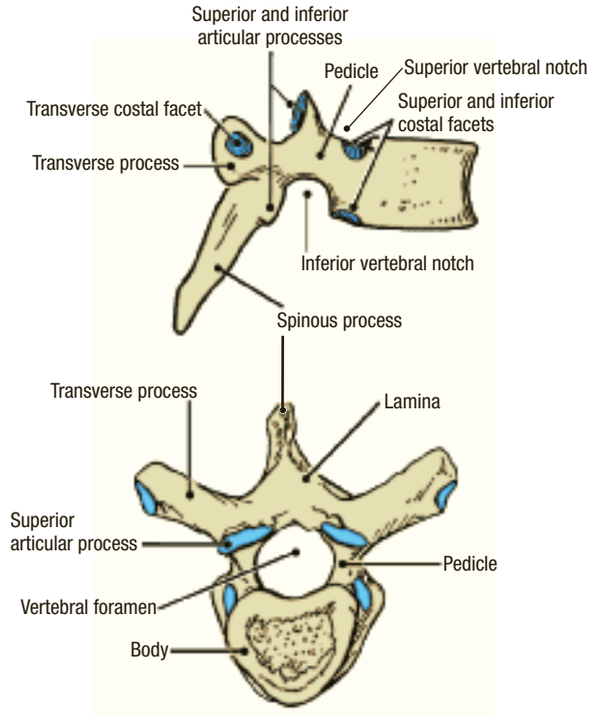


Figure 1.03. Typical thoracic vertebra in lateral and superior view.

larger vertebral foramina, shorter spinous processes that bifurcate at the tip, and transverse processes that contain a foramen transversarium. On an articulated skeleton, identify the following features common to all cervical vertebrae: **[G 284; N 15; R 186; C 418]**

- **Transverse process**
- **Foramen transversarium**
- **Spinous process**

On a skeleton, observe the following features of individual cervical vertebrae:

- **Atlas** (C1) – does not have a body.
- **Axis** (C2) – has the **dens**, which is the body of C1 that has become fused to C2 during development.
- **Vertebra prominens** (C7) – has the most prominent spinous process in the cervical region, hence its name.

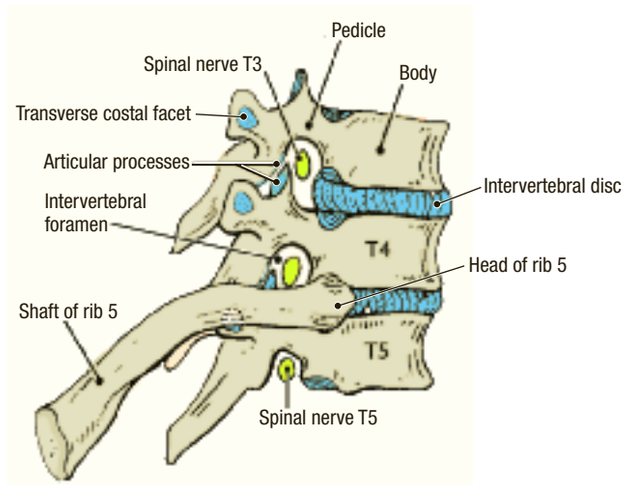


Figure 1.04. Part of the thoracic vertebral column.

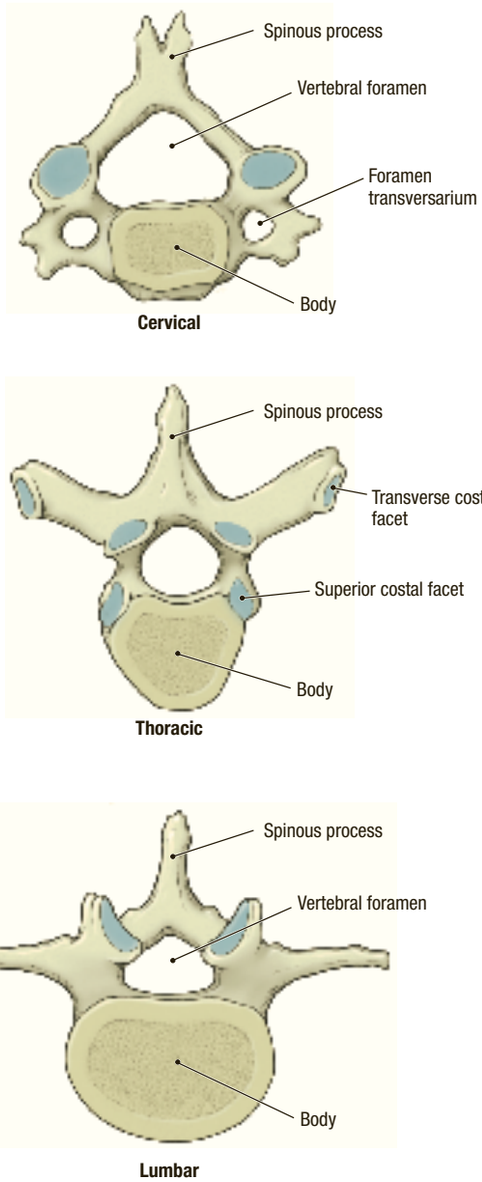


Figure 1.05. Comparison of cervical, thoracic, and lumbar vertebrae.

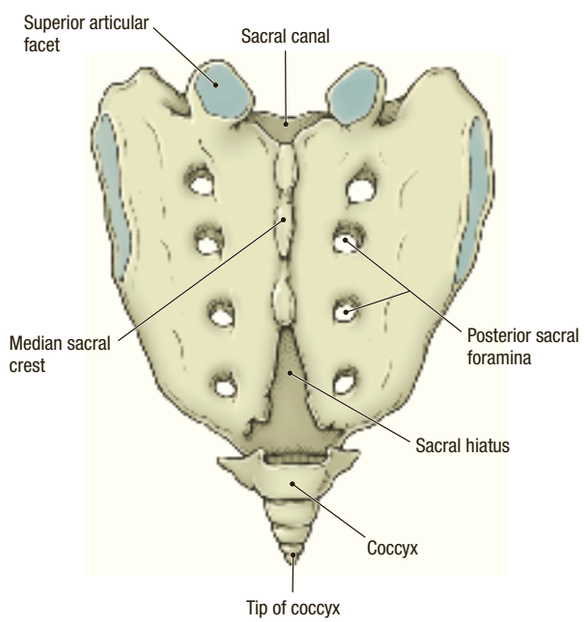


Figure 1.06. Sacrum and coccyx.

Lumbar vertebrae differ from thoracic vertebrae in the following ways (Fig. 1.05): lumbar vertebrae have larger bodies, broad spinous processes that project posteriorly, and they do not have articular facets for ribs. On a skeleton, observe the lumbar vertebrae and notice that their spines do not overlap like the spines of thoracic vertebrae. **[G 289; N 148; R 186; C 426]**

The **sacrum** is formed by five fused vertebrae and it does not have identifiable spines or transverse processes. On the dorsal surface of the sacrum, identify (Fig. 1.06): **[G 293; N 150; R 187; C 428]**

- **Median sacral crest**
- **Posterior (dorsal) sacral foramina**
- **Sacral hiatus**

The **coccyx** is a small triangular bone formed by four rudimentary coccygeal vertebrae that are fused together (Fig. 1.06).

SKIN AND SUPERFICIAL FASCIA

Before you dissect . . .

The order of dissection will be as follows: the skin will be removed from the back, posterior surface of the neck, and posterior surface of the proximal upper limb. Posterior cutaneous nerves will be studied. The superficial fascia will then be removed.

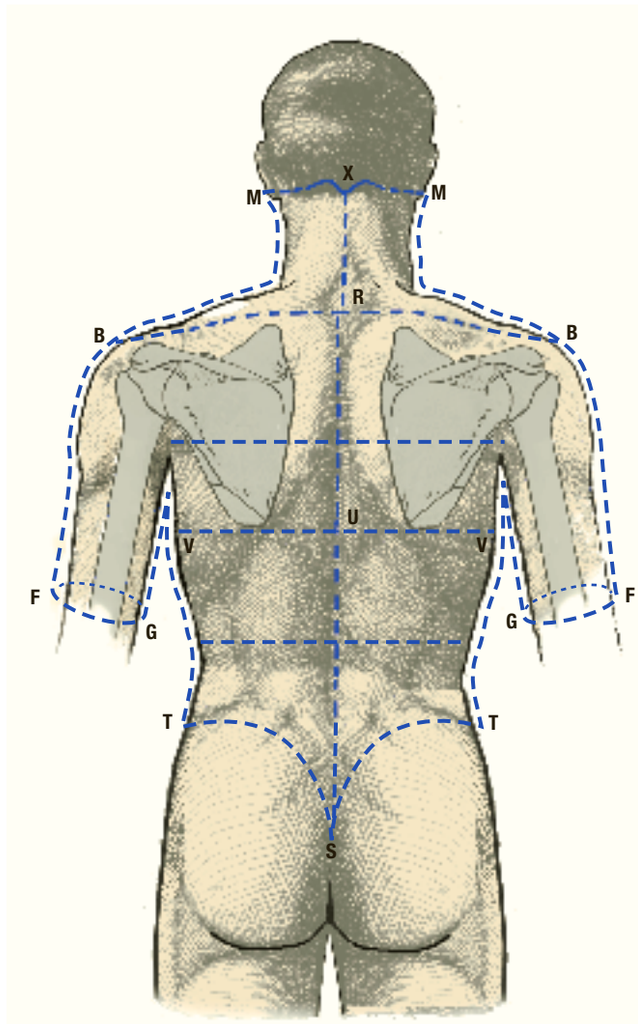


Figure 1.07. Skin incisions.

Dissection Instructions

SKIN INCISIONS

1. Refer to Figure 1.07.
2. Use a scalpel to make a vertical skin incision in the midline from the external occipital protuberance (X) to the tip of the coccyx (S). The skin is approximately 6-mm-thick in this region.
3. Make an incision from S to the midaxillary line (T). This incision should pass approximately 3 cm inferior to the iliac crest.
4. At the level of the inferior angle of the scapula, make a transverse skin incision from the midline (U) to the midaxillary line (V). To facilitate skinning, make a parallel transverse incision above and below this one.
5. Make a transverse skin incision from R to B, superior to the scapula and superior to the acromion. Extend this incision to point F, approximately halfway down the arm.
6. At point F, make an incision around the anterior and posterior surfaces of the arm, meeting on the medial side (G). If the upper limb has been dissected previously, this incision has already been made.
7. Make a skin incision that begins at G on the medial surface of the arm and extends superiorly to the axilla. Extend this incision inferiorly along the lateral surface of the trunk, through V to T.
8. Make a transverse skin incision from the external occipital protuberance (X) laterally to the base of the mastoid process (M).
9. Make an incision along the lateral surface of the neck and superior border of the trapezius muscle (M to B).
10. Remove the skin from medial to lateral. Detach the skin and place it in the tissue container.

SUPERFICIAL FASCIA

1. In the superficial fascia, locate the **occipital artery** and the **greater occipital nerve** (Fig. 1.08). First, find the occipital artery and then look on its medial side for the greater occipital nerve. The greater occipital nerve is the dorsal primary ramus of spinal nerve C2. The greater occipital nerve pierces the **trapezius muscle** approximately 3 cm inferolateral to the **external occipital protuberance**. The deep fascia in this area is very dense and tough. Therefore, it may be difficult to find the greater occipital nerve, even though it is large. **[G 307; N 171; R 212; C 414]**
2. Read a description of the **dorsal primary ramus of a spinal nerve**. The **posterior cutaneous branches** of the dorsal primary rami pierce the trapezius muscle or latissimus dorsi muscle to enter the superficial fascia (Fig. 1.08). To save time, make no deliberate effort to display posterior cutaneous branches of the dorsal primary rami. **[G 20; N 187; R 204]**
3. Reflect the superficial fascia of the back from medial to lateral. Detach the superficial fascia by cutting it along the skin incision lines and place it in the tissue container.

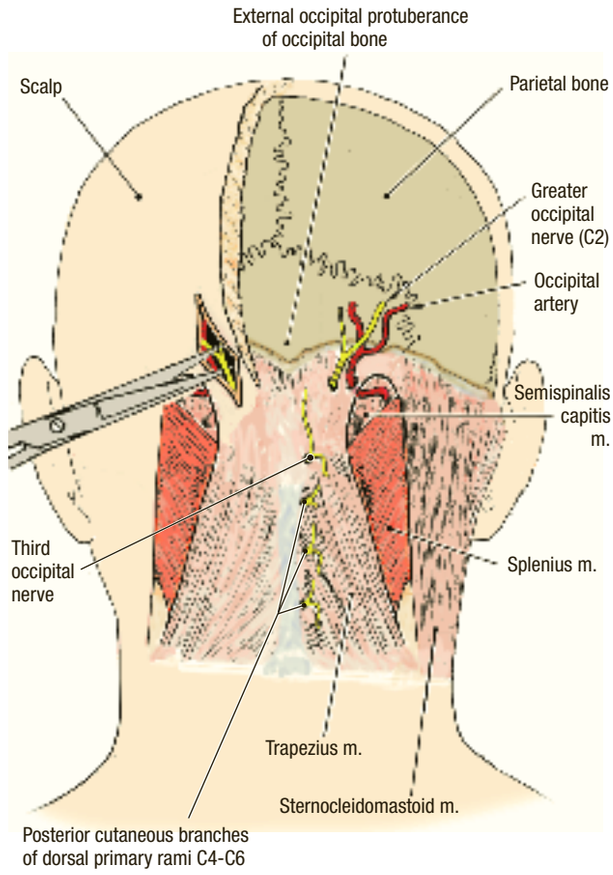


Figure 1.08. Greater occipital nerve and occipital artery.

4. In the neck, reflect the superficial fascia only as far laterally as the superior border of the trapezius muscle. *Do not cut the deep fascia along the superior border of the trapezius muscle*. The accessory nerve is superficial at this location and it is in danger of being cut.

After you dissect . . .

Review the branching pattern of a typical spinal nerve and understand that cutaneous branches of the dorsal primary rami innervate the skin of the back. Study a dermatome chart and become familiar with the concept of segmental innervation. **[G 331; N 157; C 404]**

SUPERFICIAL MUSCLES OF THE BACK

Before you dissect . . .

The **superficial muscles of the back are** also called the **posterior thoracoappendicular muscles** because they attach to the axial skeleton and the upper limb. There are five superficial muscles of the back: **trapezius**, **latissimus dorsi**, **rhomboid major**, **rhomboid minor**, and **levator scapulae**.

The order of dissection will be as follows: the superficial surface of the trapezius muscle will be cleaned. The trapezius muscle will be examined and reflected. The latissimus dorsi muscle will be studied and reflected. The rhomboid major muscle,

rhomboid minor muscle, and levator scapulae muscle will be studied. Dissection of the superficial back muscles should be performed bilaterally.

Dissection Instructions

TRAPEZIUS MUSCLE [G 307; N 167; R 212; C 407]

1. Clean the surface of the **trapezius muscle** (L. *trapezoides*, an irregular four-sided figure) (Fig. 1.09). *Do not disturb the superior border of the trapezius muscle*. Observe the proximal attachment of the trapezius muscle on the external occipital protuberance, the nuchal ligament, and the spinous processes of vertebrae C7 to T12.
2. The trapezius muscle has three parts with distinctly different actions:
   - **Superior part** of the trapezius muscle attaches to the lateral one-third of the clavicle and it elevates the scapula.
   - **Middle part** of the trapezius muscle attaches to the acromion and spine of the scapula and it retracts the scapula.
   - **Inferior part** of the trapezius muscle attaches near the medial end of the spine of the scapula and it depresses the scapula.
3. Reflect the trapezius muscle. Insert your fingers deep to the trapezius muscle, starting at the posterolateral border of the muscle (medial to the inferior angle of the scapula). Break the plane of loose connective tissue between the trapezius muscle and the deeper muscles of the back.

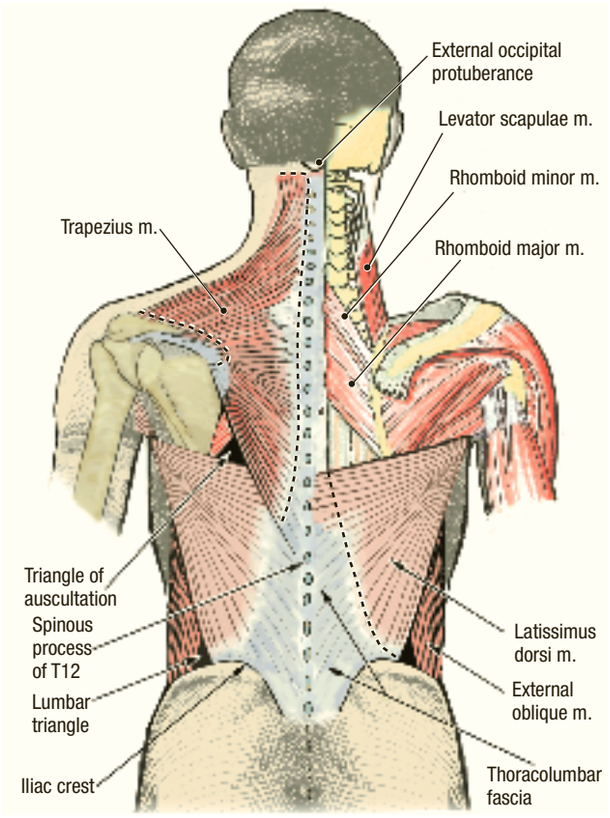


Figure 1.09. How to reflect the muscles of the back.

4. Use scissors to detach the trapezius muscle from its proximal attachment on the spinous processes and the nuchal ligament (dashed line, Fig. 1.09). Start inferiorly and continue the cut superiorly as far as the external occipital protuberance.
5. Use scissors to make a short transverse cut (2.5 cm) across the superior end of the trapezius muscle to detach it from the superior nuchal line. *Spare the greater occipital nerve, and do not extend the transverse cut beyond the border of the trapezius muscle.*
6. Use a scalpel to shave the trapezius muscle from its distal attachments on the spine and acromion of the scapula. Cut very close to the bone. Leave the trapezius muscle attached to the clavicle and cervical fascia.
7. Reflect the trapezius muscle superolaterally. Leave the cervical fascia attached along the superior border of the trapezius muscle to act as a hinge.
8. Study the deep surface of the reflected trapezius muscle. Find the plexus of nerves formed by the **accessory nerve** and **branches of the ventral primary rami of spinal nerves C3 and C4**. The accessory nerve provides motor innervation to the trapezius muscle; the branches of nerves C3 and C4 are sensory (proprioception). The superficial branch of the **transverse cervical artery** accompanies the nerves. Remove the transverse cervical vein to clear the dissection field.
9. The accessory nerve (cranial nerve XI) passes through the posterior triangle of the neck. Do not follow the nerve into the posterior triangle at this time. The posterior triangle will be dissected with the neck.

LATISSIMUS DORSI MUSCLE [G 307; N 167; R 212; C 407]

1. Clean the surface and define the borders of the **latissimus dorsi muscle** (L. *latissimus*, widest) (Fig. 1.09).
2. The proximal attachments of the latissimus dorsi muscle are the spines of vertebrae T7 to T12, the thoracolumbar fascia, and the iliac crest. The latissimus dorsi muscle also attaches to the inferior three or four ribs, lateral to their angles.
3. Note that the distal attachment of the latissimus dorsi muscle is the floor of the intertubercular sulcus on the anterior side of the humerus, but do not dissect this attachment. The latissimus dorsi muscle receives the **thoracodorsal nerve and artery** on its anterior surface near its distal attachment. The distal attachment of the latissimus dorsi muscle, its nerve, and its artery will be dissected with the upper limb.
4. Insert your fingers deep to the superior border of the latissimus dorsi muscle (medial to the inferior angle of the scapula) and break the plane of loose connective tissue between it and deeper structures. Raise the latissimus dorsi muscle enough to insert scissors and cut through its proximal attachment on the thoracolumbar fascia (dashed line, Fig. 1.09). Do not cut too close to the lumbar spinous processes.
5. Reflect the latissimus dorsi muscle laterally. It may have an attacment to the inferior angle of the scapula. Do not disturb its attachment to the scapula or its attachments to the inferior ribs.

RHOMBOID MAJOR AND RHOMBOID MINOR MUSCLES [G 308; N 170; R 212; C 407]

1. Clean the surface and borders of the **rhomboid (rhomboideus) minor muscle** and the **rhomboid major muscle** (Gr. *rhombos*, shaped like a kite). The plane of separation between the rhomboid muscles may not be obvious.
2. The proximal attachments of the rhomboid minor muscle are the nuchal ligament and the spinous processes of vertebrae C7 and T1. The distal attachment of the rhomboid minor muscle is the medial border of the scapula near the spine.
3. The proximal attachments of the rhomboid major muscle are the spinous processes of vertebrae T2 to T5. The distal attachment of the rhomboid major muscle is the medial border of the scapula inferior to the spine.
4. The rhomboid muscles retract the scapula, rotate the scapula to depress the glenoid cavity, and hold the scapula close to the thoracic wall.
5. Reflect the rhomboid muscles. Beginning at the inferior angle of the scapula, insert your fingers deep to the rhomboid major muscle and separate it from deeper muscles.
6. Use scissors to detach the rhomboid major muscle from its proximal attachments. Continue the cut superiorly and detach the rhomboid minor muscle from its proximal attachments. Reflect these two muscles laterally.
7. Examine the deep surface of the rhomboid muscles. Use blunt dissection to find the **dorsal scapular nerve** and **dorsal scapular vessels**. Remove the dorsal scapular vein to clear the dissection field. The dorsal scapular nerve and artery course parallel to the medial border of the scapula. The dorsal scapular artery may branch directly from the subclavian artery, or it may arise from the transverse cervical artery in which case it is also called the **deep branch of the transverse cervical artery**.

LEVATOR SCAPULAE MUSCLE [G 308; N 167; R 214; C 407]

1. Identify the **levator scapulae muscle** (L. *levare*, to raise).
2. Note that the proximal attachments of the levator scapulae muscle are the transverse processes of the upper four cervical vertebrae. Do not dissect its proximal attachments.
3. The distal attachment of the levator scapulae muscle is the superior angle of the scapula. The levator scapulae muscle can be seen only near its distal attachment.
4. The dorsal scapular nerve and artery supply the levator scapulae muscle. The levator scapulae muscle elevates the scapula and rotates the scapula to depress the glenoid cavity.

After you dissect . . .

Replace the superficial muscles of the back in their correct anatomical positions. Use the dissected specimen to review the proximal attachment, distal attachment, action, innervation, and blood supply of each muscle that you have dissected. Review the movements that occur between the scapula and the thoracic wall. Use an illustration to observe the origin of the transverse cervical artery and the dorsal scapular artery. Observe two triangles associated with the latissimus dorsi muscle: The **triangle of auscultation** and the **lumbar triangle (of Petit)** (Fig. 1.09).

CLINICAL CORRELATION

Triangles of the Back [G 4.28, 4.29; N 246]

The **triangle of auscultation** is bounded by the latissimus dorsi muscle, the trapezius muscle, and the rhomboid major muscle. Within the triangle of auscultation, intercostal space 6 has no overlying muscles. This area is particularly well-suited for auscultation (listening to sounds produced by thoracic organs, particularly the lungs).

The **lumbar triangle** is bounded by the latissimus dorsi muscle, the external oblique muscle, and the iliac crest. The floor of the lumbar triangle is the internal oblique muscle of the abdomen. On rare occasions, the lumbar triangle is the site of a lumbar hernia.

INTERMEDIATE MUSCLES OF THE BACK [G 308; N 167; R 219; C 408]

Dissection Instructions

The **intermediate muscles of the back** are the **serratus posterior superior muscle** and the **serratus posterior inferior muscle.** These are very thin muscles, which may be accidentally reflected with the rhomboid muscles or the latissimus dorsi muscle. If you do not see the serratus posterior muscles, look for them on the deep surface of the rhomboid muscles or the latissimus dorsi muscle.

1. The proximal attachments of the **serratus posterior superior muscle** are the nuchal ligament and the spinous processes of vertebrae C7 to T3. Its distal attachments are the superior borders of ribs 2 to 4, lateral to their angles.
2. The proximal attachments of the **serratus posterior inferior muscle** are the spinous processes of vertebrae T11 to L2. Its distal attachments are the inferior borders of ribs 8 to 12, lateral to their angles.
3. The serratus posterior muscles are respiratory muscles, and they are innervated by intercostal nerves.
4. Detach both serratus posterior muscles from the spinous processes. Reflect the muscles laterally, leaving them attached to the ribs.

DEEP MUSCLES OF THE BACK

Before you dissect . . .

The **deep muscles of the back** act on the vertebral column. There are many deep muscles of the back (Fig. 1.10) and only a few will be dissected: **splenius muscle, semispinalis capitis muscle,** and **erector spinae muscle**. All of the deep muscles of the back are innervated by dorsal primary rami of spinal nerves.

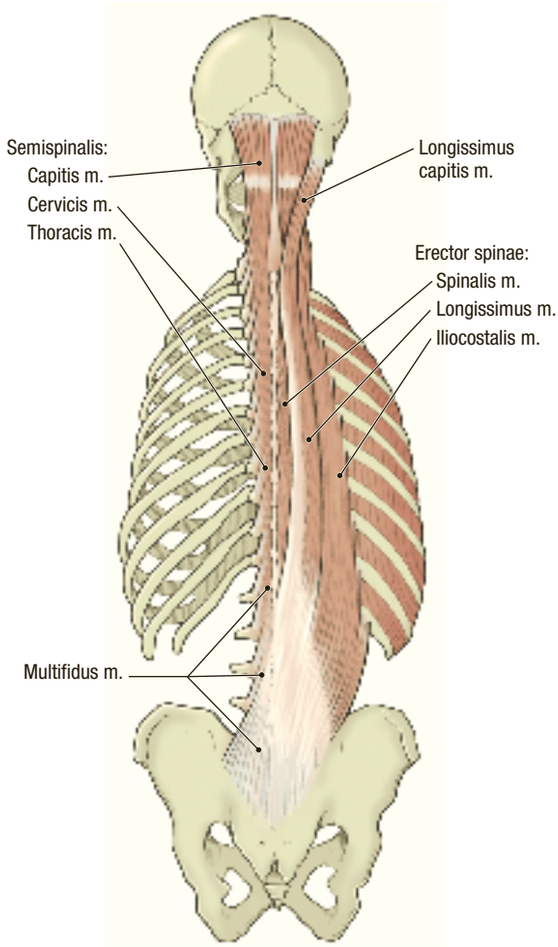


Figure 1.10. Deep muscles of the back.

The order of dissection will be as follows: the deep muscles of the posterior neck (splenius and semispinalis capitis) will be studied. The erector spinae muscle will be dissected and its component parts will be identified.

Dissection Instructions

SPLENIUS MUSCLE [G 309; N 167; R 212; C 408]

1. Identify the **splenius muscle** (Gr. *splenion*, bandage). The splenius muscle lies deep to the trapezius muscle and its fibers course obliquely across the neck. The proximal attachment of the splenius muscle is the nuchal ligament and the spinous processes of vertebrae C7 to T6.
2. The splenius muscle has two parts that are named according to their distal attachments:
   - **Splenius capitis muscle** (L. *caput*, head) is attached to the mastoid process of the temporal bone and the superior nuchal line of the occipital bone.
   - **Splenius cervicis muscle** (L. *cervix*, neck) is attached to the transverse processes of the vertebrae C1 to C4.
3. Detach the splenius muscle from the nuchal ligament and the spinous processes of vertebrae C7 to T6.
4. Reflect the muscle laterally, leaving its distal attachments undisturbed.

SEMISPINALIS CAPITIS MUSCLE [G 311; N 168; R 214; C 409]

1. Identify the **semispinalis capitis muscle** (L. *semi*, half; L. *spinalis*, spine) (Fig. 1.10). The semispinalis capitis muscle lies deep to the splenius muscle and its fibers course vertically, parallel to the long axis of the neck. The inferior attachments of the semispinalis capitis muscle are the transverse processes of the upper thoracic vertebrae.
2. The superior attachment of the semispinalis capitis muscle is the occipital bone between the superior and inferior nuchal lines. Note that the greater occipital nerve passes through the semispinalis capitis muscle.
3. Do not dissect the semispinalis capitis muscle further at this time.

ERECTOR SPINAE MUSCLE [G 309; N 168; R 214; C 409]

1. The erector spinae muscle lies deep to the serratus posterior muscles. The erector spinae muscle is composed of three columns of muscle.
2. Use a scalpel to incise the posterior surface of the **thoracolumbar fascia**. Use blunt dissection to remove it from the posterior surface of the erector spinae muscle.
3. The columns of the erector spinae muscle are fused at the level of their inferior attachments to the sacrum and ilium. Use your fingers to separate the columns at thoracic levels.
4. Identify the **three columns of the erector spinae muscle** (L. *erector*, one who erects) (Fig. 1.10):
   - **Spinalis muscle** forms the medial column of the erector spinae muscle. The inferior attachments of the spinalis muscle are on spinous processes. Its superior attachments are also on spinous processes. The spinalis muscle is present at lumbar, thoracic and cervical vertebral levels.
   - **Longissimus muscle** (L. *longissimus*, the longest) is the intermediate column of the erector spinae muscle. Its inferior attachment is on the sacrum and its superior attachments are the transverse processes of the thoracic and cervical vertebrae. Note that its most superior portion, the **longissimus capitis muscle**, attaches to the mastoid process of the temporal bone.
   - **Iliocostalis muscle** is the lateral column of the erector spinae muscle. Its inferior attachment is the ilium (iliac crest) and its superior attachments are on ribs (L. *costa*, rib).
5. All three columns of the erector spinae muscle extend the vertebral column when both sides work together. If only one side is active, the erector spinae muscle bends the vertebral column laterally toward the side that is active.

TRANSVERSOSPINAL GROUP OF MUSCLES [G 312; N 169; R 215; C 411]

The **transversospinal group of muscles** is located deep to the erector spinae muscle. The muscles in the transversospinal group attach to transverse processes and spinous

processes (Fig. 1.10). The muscles of the transversospinal group cause rotational and lateral bending movements between adjacent vertebrae and act to stabilize the vertebral column. A number of muscles comprise this group: **semispinalis**, **multifidus**, and, more deeply, **rotatores**. The semispinalis capitis muscle has been dissected. Do not dissect the other muscles of the transversospinal group.

After you dissect . . .

Use the dissected specimen to review the location, innervation, and action of each column of muscles in the deep group of back muscles.

SUBOCCIPITAL REGION

Before you dissect . . .

On a skull, identify (Fig. 1.02): **[G 592; N 8; R 50; C 498]**

- **Superior nuchal line**
- **Inferior nuchal line**
- **External occipital protuberance**
- **Foramen magnum**

On the **atlas** (C1 vertebra), identify (Fig. 1.11): **[G 282; N 15; R 193; C 418]**

- **Posterior tubercle**
- **Posterior arch**
- **Groove for the vertebral artery**
- **Transverse process**
- **Foramen transversarium**

On the **axis** (C2 vertebra), identify (Fig. 1.11):

- **Spinous process**
- **Transverse process**
- **Foramen transversarium**

The order of dissection will be as follows: the greater occipital nerve will be identified and followed deeply. The semispinalis capitis muscle will be reflected. The muscles that bound the suboccipital triangle will be identified. The contents of the suboccipital region (vertebral artery and suboccipital nerve) will be studied.

Dissection Instructions

1. Identify the **semispinalis capitis muscle** (Fig. 1.12). **[G 314; N 169; R 227; C 409]**
2. Once again, find the **greater occipital nerve**. Use blunt dissection to trace the greater occipital nerve through the semispinalis capitis muscle. Detach the semispinalis capitis muscle close to the occipital bone and reflect it inferiorly.
3. Deep to the semispinalis capitis muscle, follow the greater occipital nerve to the lower border of the **obliquus capitis inferior muscle**. Note that the greater occipital nerve (C2) emerges between vertebrae C1 and C2.
4. Identify and clean the three muscles that form the **boundaries of the suboccipital triangle** (Fig. 1.12): **[G 317; N 171; R 228; C 417]**
   - **Obliquus capitis inferior muscle** forms the inferior boundary of the suboccipital triangle. Verify that the proximal attachment of the obliquus capitis inferior muscle is the spinous process of the axis (C2). Its distal attachment is onto the transverse process of the atlas (C1).

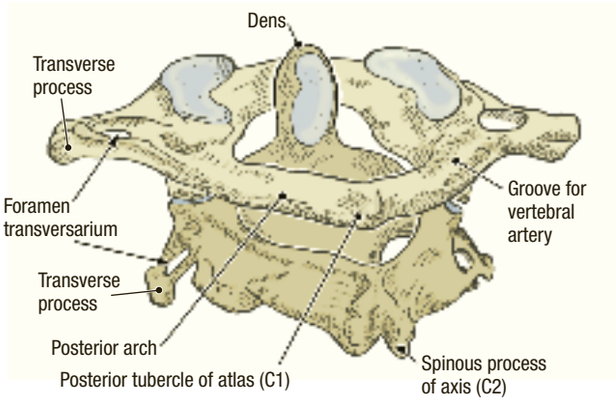


Figure 1.11. Features of the atlas (C1) and axis (C2).

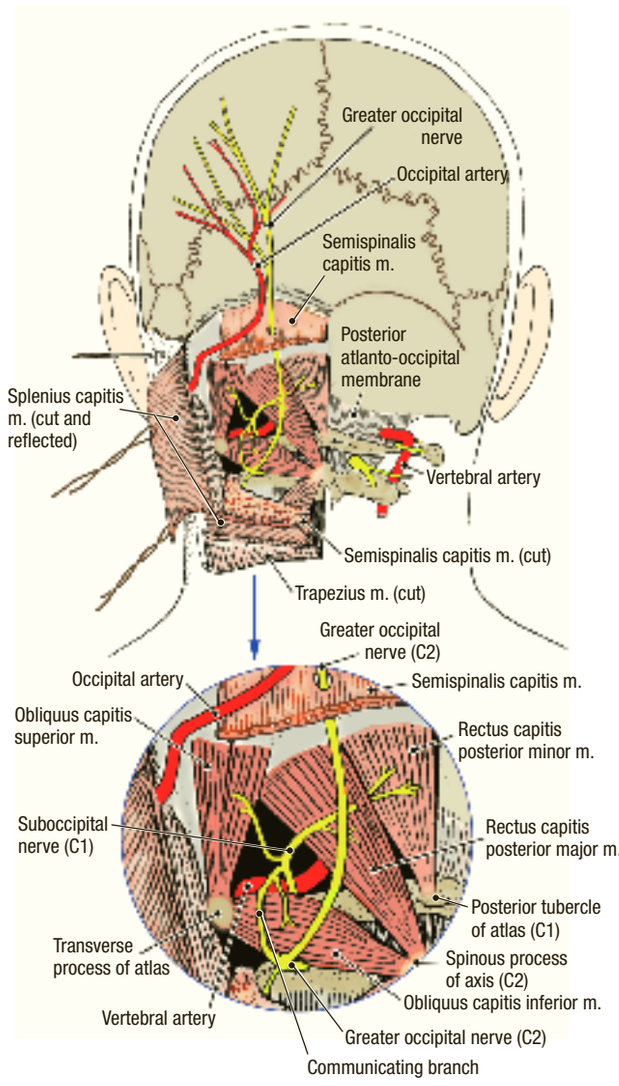


Figure 1.12. Suboccipital region.

- **Rectus capitis posterior major muscle** forms the medial boundary of the suboccipital triangle. Confirm that the proximal attachment of the rectus capitis posterior major muscle is the spinous process of the axis. Its distal attachment is the inferior nuchal line of the occipital bone.
- **Obliquus capitis superior muscle** forms the lateral boundary of the suboccipital triangle. Confirm that the inferior attachment of the obliquus capitis superior muscle is the transverse process of the atlas. Its superior attachment is the occipital bone between the superior and inferior nuchal lines.

5. The muscles that bound the suboccipital triangle produce extension and lateral bending of the head at the atlanto-occipital joints, and rotation of the head at the atlantoaxial joints.
6. The **contents of the suboccipital triangle** are the **suboccipital nerve** and the **vertebral artery** (Fig. 1.12). Note that the suboccipital nerve (dorsal primary ramus of C1) emerges between the occipital bone and vertebra C1. The suboccipital nerve supplies motor innervation to the muscles of the suboccipital region. The suboccipital nerve is unique among dorsal primary rami in that it has no cutaneous distribution.
7. Identify the **vertebral artery**. Use an illustration to study the course of the vertebral artery through the neck and into the skull. **[G 319; N 130; R 166; C 458]**

After you dissect . . .

Review the actions of the suboccipital muscles. Review the distribution of the branches of a thoracic dorsal primary ramus and compare the thoracic pattern to the distribution of the dorsal primary rami of spinal nerves C1 to C3.

VERTEBRAL CANAL, SPINAL CORD, AND MENINGES

Before you dissect . . .

The **vertebral canal** is a bony tube formed by the stacked **vertebral foramina** of the **cervical vertebrae**, **thoracic vertebrae**, **lumbar vertebrae**, and the **sacral canal** (Fig. 1.13). The vertebral canal encloses and protects the **spinal cord**, its membranes (**spinal meninges**), and blood vessels. The spinal cord begins at the foramen magnum of the occipital bone and usually terminates in the adult at the level of the second lumbar vertebra. Because the spinal cord is shorter than the vertebral canal, *the spinal cord segments are found at higher vertebral levels than their names would suggest* (Fig. 1.13).

The spinal cord is not uniform in diameter throughout its length. It has a **cervical enlargement** (Fig. 1.13) that corresponds to spinal cord segments C4 to T1 and a **lumbar enlargement** that corresponds to spinal cord segments L2 to S3. There are 31 pairs of **spinal nerves** (8 cervical; 12 thoracic; 5 lumbar; 5 sacral; 1 coccygeal) (Fig. 1.13), which emerge between adjacent vertebrae. Spinal nerves are numbered according to the vertebra above. However, *in the cervical region, spinal nerves are numbered for the vertebra below, and the C8 spinal nerve does not have a correspondingly numbered vertebra.*

The order of dissection will be as follows: the erector spinae muscles will be removed to expose the laminae of the vertebrae. The laminae will then be cut and removed (laminectomy) to expose the spinal meninges. The spinal meninges will be examined and will be opened to expose the spinal cord. The spinal cord will then be studied.

Dissection Instructions

1. *Wear eye protection for all steps that require the use of a chisel, bone saw, or bone forceps.*
2. Use a scalpel to remove the erector spinae muscles bilaterally from vertebral levels C4 to S3. The laminae must be clearly exposed. Use scraping motions with a chisel to clean the laminae after the muscles have been removed.
3. Use a chisel or power saw to cut the **laminae** of vertebrae T6 to T12 on both sides of the spinous processes (Fig. 1.14). Make this cut at the lateral end of the laminae to gain wide exposure to the vertebral canal. The cutting instrument should be angled at 45 degrees to the vertical.
4. Use a scalpel to cut the interspinous ligaments between vertebrae T5 and T6 and between vertebrae T12 and L1. Leave the remaining interspinous ligaments undisturbed to maintain the laminectomy specimen intact.
5. Use a chisel to pry the six spinous processes and their laminae out as a unit. The dura mater will be undamaged.
6. Observe the **ligamenta flava** on the deep surface of the laminectomy specimen. The ligamenta flava connect the laminae of adjacent vertebrae.
7. Continue the laminectomy procedure superiorly and inferiorly from the opening in the vertebral canal. Exercise caution in lower lumbar and sacral regions, because the vertebral canal curves sharply posteriorly (Fig. 1.15A). Do not drive the chisel or push the saw through the sacrum into the rectum.
8. When finished with the laminectomy, you should see the posterior surface of the dura mater from vertebral levels C4 to S2.

SPINAL MENINGES

1. Observe the **epidural (extradural) space**. Use blunt dissection to remove the **epidural fat** and the **posterior internal vertebral venous plexus** from the epidural space. **[N 163]**

CLINICAL CORRELATION

Vertebral Venous Plexuses

The veins of the vertebral venous plexuses are valveless, permitting blood to flow superiorly or inferiorly depending on blood pressure gradients. The vertebral venous plexuses can serve as routes for metastasis of cancer from the pelvis to the vertebrae, vertebral canal, and cranial cavity.

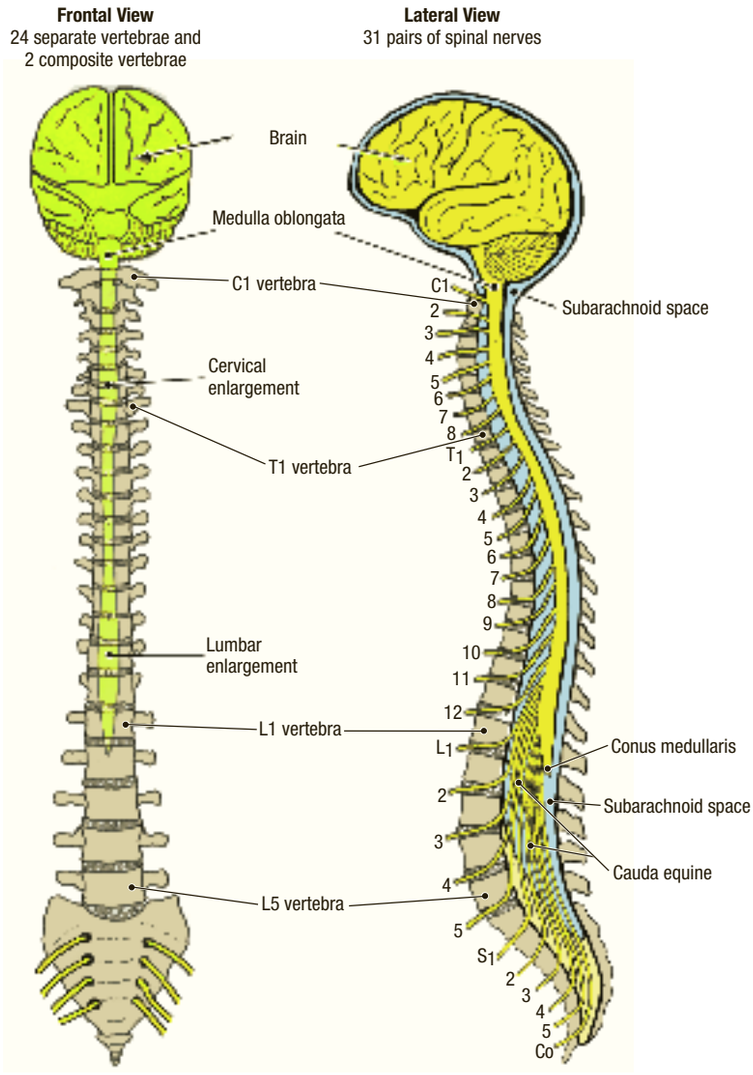


Figure 1.13. The spinal cord within the vertebral canal.

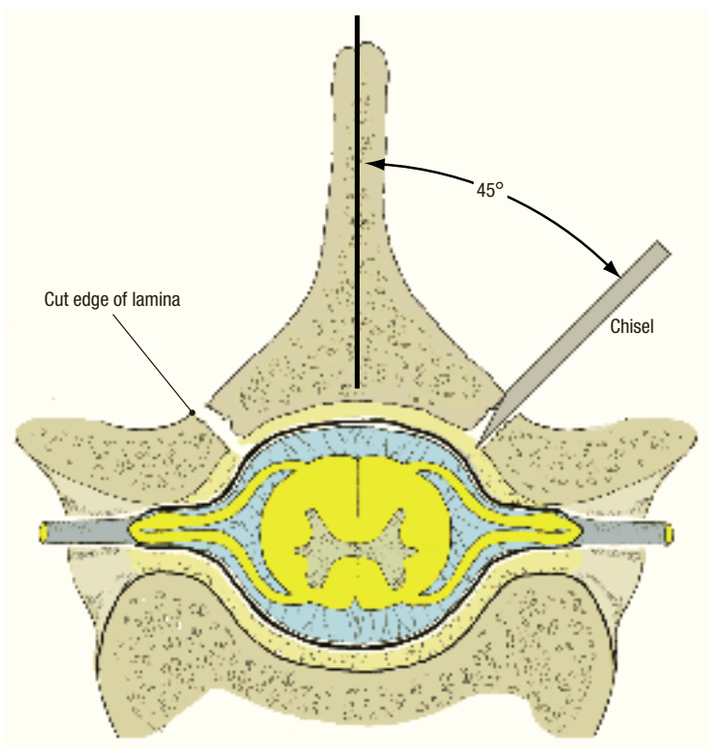


Figure 1.14. How to open the vertebral canal.

2. Identify the **dural sac**, which ends inferiorly at vertebral level S2 (Fig. 1.15A). **[G 324; R 221; C 430]**
3. In the thoracic region, lift a fold of **dura mater** with forceps and use scissors to cut a small opening in its dorsal midline. Use scissors to extend the cut superiorly as far as C4 and inferiorly to S2. Do this without damaging the underlying arachnoid mater. Retract the dura mater and pin it back.
4. Identify the **arachnoid mater** (Fig. 1.16). It is very delicate. Incise the arachnoid mater in the dorsal midline and observe the **subarachnoid space**. The subarachnoid space contains cerebrospinal fluid in the living person but not in the cadaver. **[G 325; N 162; C 431]**
5. Retract the arachnoid mater and observe the **spinal cord**. The spinal cord is completely invested by **pia mater**, which is on the surface of the spinal cord and cannot be dissected from it.
6. Identify the following features of the spinal cord: **[G 322; N 153; R 220; C 430]**
   - **Cervical enlargement** (spinal cord segments C4 to T1) provides nerves to the upper limb.
   - **Lumbar enlargement** (spinal cord segments L2 to S3) provides nerves to the lower limb.
   - **Conus medullaris (medullary cone)** is the end of the spinal cord located between vertebral levels L1 and L2.
   - **Cauda equina** (L., tail of horse) is a collection of ventral and dorsal roots in the lower vertebral canal (Fig. 1.15B).

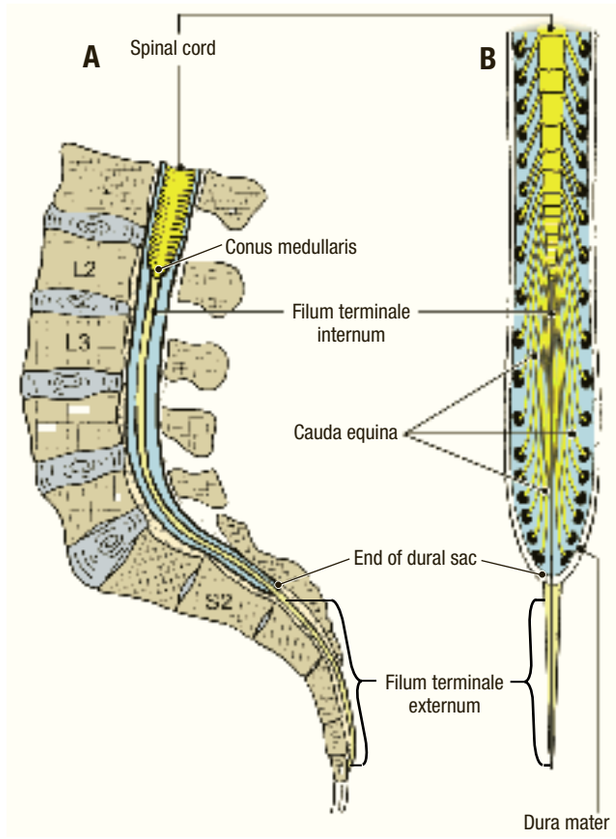
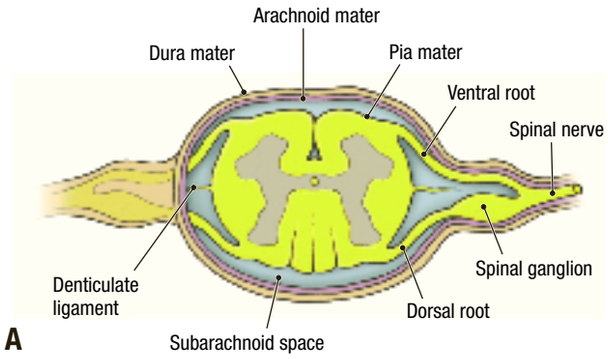


Figure 1.15. Lower portion of the vertebral canal and spinal cord. **A.** Lateral view. **B.** Posterior view.

- **Filum terminale internum** (Fig. 1.15A,B) is a delicate filament continuous with the pia mater. It arises from the inferior tip of the conus medullaris and ends at S2 where it is encircled by the lower end of the dural sac.
- **Filum terminale externum (coccygeal ligament)** (Fig. 1.15A,B) is the continuation of the filum terminale internum below vertebral level S2. The filum terminale externum passes through the sacral hiatus and ends by attaching to the coccyx.

7. The pia mater forms two **denticulate ligaments**, one on each side of the spinal cord (Fig. 1.16). Each denticulate ligament has 21 teeth and each tooth is attached to the inner surface of the dura mater, anchoring the spinal cord. **[G 327; N 162; R 221; C 431]**
8. Use a probe to follow **dorsal roots** and **ventral roots** to the point where they pierce the dura mater and enter the **intervertebral foramen** (Fig. 1.16). The dorsal roots are on the dorsal side of the denticulate ligament and the ventral roots are on the ventral side of the denticulate ligament. The spinal nerve will be formed outside of the vertebral canal by the joining of the dorsal and ventral roots.
9. Observe small **blood vessels** that course along the ventral and dorsal roots. These are branches of posterior intercostal, lumbar, or vertebral arteries, depending on vertebral level. They pass into the vertebral canal through the intervertebral foramen and supply the spinal cord. **[G 329; N 165; C 431]**
10. In the thoracic region, expose one **spinal nerve**. Place a probe into an intervertebral foramen to protect the nerve within it. Use bone forceps to remove the posterior wall of the intervertebral foramen and expose the **spinal ganglion** (dorsal root ganglion) (Fig. 1.16). Distal to the spinal ganglion, identify the spinal nerve and follow it distally to the point where it divides into a **dorsal primary ramus** and a **ventral primary ramus**.



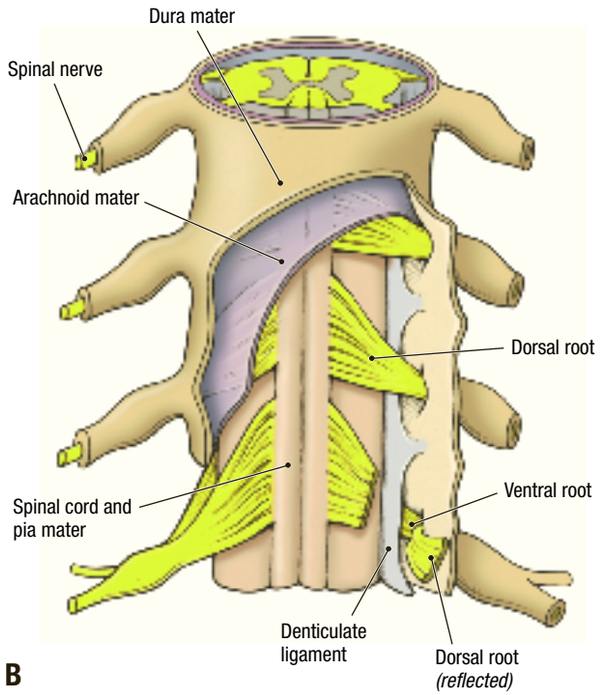


Figure 1.16. Relationships of the meninges to the spinal cord and nerve roots. **A.** Transverse section. **B.** Posterior view.

CLINICAL CORRELATION

Lumbar Puncture

Cerebrospinal fluid (CSF) can be obtained from the subarachnoid space inferior to the conus medullaris (Fig. 1.17). At this level, there is no danger of penetrating the spinal cord with the puncture needle.

After you dissect . . .

Review the formation and branches of a typical spinal nerve. Describe the way that the deep back muscles receive their innervation. Review the coverings and parts of the spinal cord and study an illustration that shows the blood supply to the spinal cord. Consult a dermatome chart and relate this pattern of cutaneous innervation to the spinal cord segments. **[G 331; N 157; C 404]**

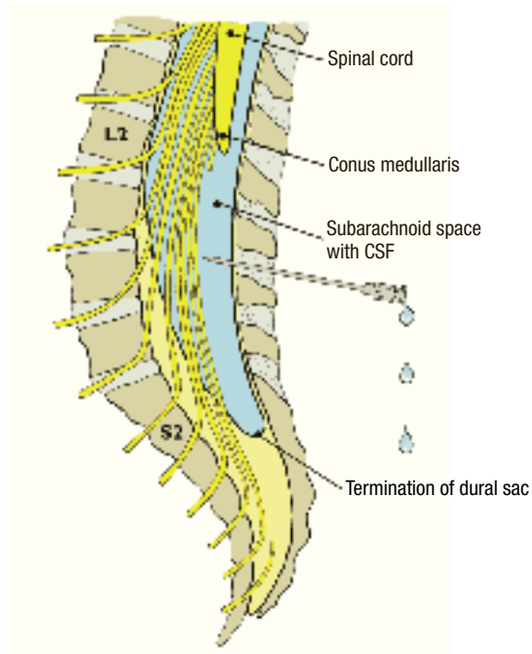


Figure 1.17. Lumbar puncture for removal of cerebrospinal fluid.